Step by Step Instructions
For
Visualizing Waveform, Elevation, and LIDAR Products

For The Science Team
To Understand the GLAS Standard Products

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Revised May 2011

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1.0 Introduction

The purpose of this document is to walk GLAS science team members and data users through several scenarios to give them an understanding of the visualizer capabilities and the GLAS standard data products. The scenarios listed in this set of instructions are designed to show them how the visualizer can be used to investigate science algorithm performance, understand what parameters are written on each GLAS standard product, and how the products interact with each other. By running the scenarios, the user will understand what information is contained in each GLAS standard data product and how they interact which each other. At this time the visualizer works with all the waveform and elevation products, GLA01, 05, 06, and 12-15 and all LIDAR products, GLA02 and 07-11. The GLA04-LPA engineering product can also be viewed with the visualizer.

2.0 Data Availability

A data set of simulated data has been created for all waveform, elevation, and lidar GLAS standard products. For purposes of this tutorial, we have created product sets only for the region surrounding Greenland and have put these on each remote site. The data are from laser 2A, release 31, 91-day repeat orbit 2103, cycle 2, tracks 2 and 10. The data are in /SCF/product_sets/R31_tutorial_data.

The GLAS standard products that have been created include:

GLA01 – waveforms and accompanying instrument parameters.
GLA04 – LPA only – laser profiling array data.
GLA05 – waveform parameterization.
GLA06 - global elevation product with elevations, surface characteristics, geodetic corrections, precision orbit and attitude.
GLA07 - calibrated backscatter profiles.
GLA08 – aerosol layer heights.
GLA09 – cloud layer heights.
GLA10 – cloud and aerosol layer backscatter and extinction cross-section profiles.
GLA11 – cloud and aerosol layer optical properties.
GLA12 - information similar to GLA06 within the ice sheet mask supplied by the science team with all science parameters calculated using ice sheet specific algorithms described in the ATBD.
GLA13 - information similar to GLA06 within a sea ice mask with all science parameters calculated using sea ice specific algorithms described in the ATBD.
GLA14 - information similar to GLA06 within the land mask supplied by the science team with all science parameters calculated using land specific algorithms described in the ATBD.
GLA15 - information similar to GLA06 within the ocean mask supplied by the science team with all science parameters calculated using ocean specific algorithms described in the ATBD.

3.0 Required Hardware and Software

PC, Macintosh, or Linux with terminal and X-Window server software. For PCs, we use X-Win32 v9.3 from StarNet Communications, http://www.starnet.com, but several others are available, eg. Hummingbird's Exceed. For Macintoshes, the X server software comes with recent versions of OSX, but it may not be installed by default. We recommend setting your display for 24- or 32-bit color or better. (You can also use an x-terminal but you will have problems with the colors flashing as you move in and out of windows).

Access to one of the Remote SCFs (rSCFs) or the Main SCF (mSCF). We keep the latest SCF visualizer software installed on all of these machines.

4.0 Invoking the Visualizer

Steps to follow to invoke the visualizer:

1.0 Start your X-Windows server software, if it's not already running. The exact steps to do this vary depending on whether you're using a PC, Macintosh, or Linux. If you are unsure how to do this, ask your local system administrator.

2.0 Open a terminal window to the mSCF or rSCF and log in. Again, if you're unsure how to do this, ask your local sys admin.

3.0 Especially if you're new to this, it's a good idea to make sure the $DISPLAY environment variable is set. In the terminal window, type:

```
echo $DISPLAY
```

If it's set, you'll probably see a string of numbers, or the hostname. If not, you'll either see nothing, or get a message that says "Undefined variable".

4.0 Start the visualizer from the terminal window by typing:

- On the mSCF (icesat0):
"/SCF/bin/ops/run_mscf_visualizer.ksh" on the command line (following the >).

- On the remote SCFs:
"**glas_visualizer**" on the command line (following the >). This is an alias to invoke /SCF/bin/ops/run_visualizer.ksh

Push "enter" and the visualizer GUI should pop up.

If your X-Windows server software is not running, or $DISPLAY variable is not set (or set incorrectly), you will get errors probably similar to one of these:

- X connection to 128.183.107.205:10.0 broken (explicit kill or server shutdown).

- % DEVICE: Unable to connect to X Windows display: :0.0
  % DEVICE: Unable to open X Windows display.
  Is your DISPLAY environment variable set correctly?
  % Execution halted at: $MAIN$

5.0 Running Scenarios

This section runs you step by step through several scenarios in the visualizer. If you are in the middle of a scenario and cannot get out gracefully look at the terminal window. If there is an IDL prompt (IDL>) just type "exit" (no quotes) after the prompt. If there is no IDL prompt, then click in the terminal window and do a "ctrl c". If an IDL prompt still does not occur then click in a GUI window. Once the IDL prompt occurs type "exit". You should then see a UNIX command line prompt > in the terminal window. To get back into the visualizer just redo step 5.0 of section 4.0

These scenarios assume you have already invoked the visualizer and you are looking at the SCF_VISUALZER window. To push a button on a GUI, use the mouse to move the cursor over that button and push the left mouse button. All instructions that say "click" or "push" assume you are clicking the left mouse button unless the right mouse button is stated explicitly.

5.1 Waveform and Elevation Scenario 1

The purpose of this scenario is to look at the waveform and the waveform parameterization to see what the raw return may look like and the results of the waveform-processing algorithm.

Step 1.0 Push "**Select from Data Base**". The SCF viewer GUI appears.

Step 2.0 **Set the data directory.** Use the "**Pick"** button to select **/SCF/product_sets/R31_tutorial_data**.

Step 3.0 Change "**Data Release**" to 31.

Step 4.0 **Choose products.** Go to the top left and push the button "Data Product Menu". The Product Selection window pops up. Click the squares next to the first two products, GLA01 and GLA05. Push "Done" in bottom of product selection window. You should now be returned to the SCF Viewer window.

Step 5.0 **Select geographic region.** Push "Show GLAS Coverage on Map" button half way down the GUI on the right. The Map GUI should now pop up. At the top under "Select Region:" push the button next to Greenland. Note that the numbers in the latitude and longitude text boxes change accordingly.

Step 6.0 (Optional) You can also view the map as a shaded-relief or gray-scale elevation **DEM.** Just push the appropriate radio button at the top under "Select Map Style:"

Step 7.0 (Optional) Push the "**Plot Map**" button to replot the map only for the Greenland Region. The map should now show just the selected region. It will appear as a DEM if you executed step 6.

Step 8.0 (Optional) **Show available data groundtracks.** Push the "Add Groundtracks" button and then push the "91-Days repeat" from the pull down menu that appears. You will see a list of the tracks that exist in the data set on your machine under "91 Days Track List" on the right. Note: 8-Days repeat tracks are not available in R31_tutorial_data.

Step 9.0 (Optional) To highlight a specific track push the track number on the list. An * will occur next to that number and the groundtrack will appear in a different color. At this point you may either select each track individually (and then press the "**Load Tracks to Main Window**" button), or you can push the "**Select All**" button to select all tracks, or you may follow step 10 to select all tracks as well.

Note: When dealing with greater number of tracks, the user can set the "**Start Track**" and the "**Number of Tracks to Display**" to the desired number. The "**Number of Tracks Left**" will be shown depending on user's input.

Return to SCF Viewer window. Push the "close" button in the bottom right of the Map GUI. You now should see the SCF Viewer window. Note that the latitude and longitude text boxes now contain the coordinates for the region you selected.

Step 10.0 **Select Tracks.** (Not necessary if you did step 9). In the bottom left half of the window under "91 Day Revolution" push the "**Push to List Tracks w/I Region**" button. In the text window to the left under that button a list of tracks will appear. Push the circle next to "Select All" to select all the tracks. The tracks selected will be highlighted in black in the text window.

Step 11.0 **Start visualizing data.** Push the "**continue**" button in the bottom right corner.

Step 12.0 Click "**Visualizer**" in the intermediate window that pops up. This window allows the user to visualize data, view browse products or create subset products by selecting "**Visualizer**", "**View Browse Products**" or "**Create Subset Products**" respectively.

Note: See section 5.3 for further details on viewing browse products.

Step 13.0 First an "**Elevation PROFILES**" window will pop up showing decimated elevation profiles of each pass selected. Next a "Groundtracks" GUI will pop up showing the groundtracks on a map. These are also decimated.

Step 14.0 **Zoom in the "Groundtracks" window to enlarge region of interest.** Under "Select Region" push the radio button next to Greenland. Then push "Replot Map" (top left just above map). A blow up of the Greenland region appears. You can view the map as either gray regions or a shaded-relief DEM by pressing the radio buttons under "Select Map Style", then pushing "Replot Map".

Step 15.0 **Look at product parameters for a specific pass.** Right clicking with the mouse in any profile box will show that pass highlighted in the "Groundtracks" window. Go to the "Elevation PROFILES" window and left click in the top profile. A "GLAS Series Plot Sets: Pass 21030020002" window will pop up and the ground track for this pass is highlighted in the "Groundtracks" window.

Step 16.0 **Select what set of parameters to view.** In the "GLAS Series Plot Sets: Pass 21030020002" window the parameters have been grouped by subject matter into plot sets. The plot sets available to look at are dependent on what products you selected. Since GLA01 and GLA05 products were chosen, you should see the following plot sets:

- Elevations
- Waveform Characteristics
- Range Increments
- Range Corrections
- Angles
- Flags
- Waveform Intensity Series

Click the boxes next to "Elevations" and "Waveform Characteristics". Then push the "Display Selected Plotsets" button. It will take a few seconds (20 or so) to load the parameters. Two windows will appear: one with "GLAS WF_CHAR:" and one with "GLAS ELEVATION".

Step 17.0 **GLAS WF_CHAR window:** Initially the transmitted energy and received energy profiles are plotted.

From the "Curves…" menu you can also plot:

- Received and transmitted energy from GLA01.
- Received and transmitted gain from GLA01 and/or GLA05.
- Waveform compression information.
- The difference in km between the received echo peak and the transmitted waveform peak.
- How close the echo peak is to the last telemetered gate.
- The width of the signal based on first and last threshold crossings.
- The difference between the first threshold crossing and the last gate.
- The time in digitizer counts (ns from turn on of the digitizer) of the transmitted peak.
- The echo peak location in digitizer counts.
- The maximum amplitude of the smoothed waveform.

The bottom plot in the plot set shows the difference between any two parameters available in this plot set.

17.1 **See what parameters are available to plot in this window.** Click on the "Choose Curves" button. A curves window appears showing you which parameters are available to plot. Parameters for GLA01 and GLA05 appear in separate tabbed lists. The GLA01 list is shown by default.

17.2 **Change properties of specific curve.** Go to the "Received Energy, Max Peak (fJ)". curve. The Show button will be indented indicating that the curve is displayed. Select the "Properties" button next to the curve. A new window will pop up that will allow you to change the curve properties of just this parameter. Click the radio button next to "red". Then push the "OK" button in bottom of window. Now press the "Apply properties" button on the curves window. Note that the Received Energy is now shown in red.

17.3 **Output the values in a curve to an ASCII file.** Repeat the step above, but click on "Output" instead of "Properties". You may see the x and y data values output to a window by selecting either of the "Show (…) in window" buttons. To output the values to a file, select either "Programmer style to file" or "Spreadsheet style to file". "Programmer style" writes the entire X array, followed by the entire Y array; this is easier for programs like IDL to read. "Spreadsheet style" writes the X and Y arrays as columns. A new window pops up that lets you choose the file in which to write the

data. Make sure you have write permissions in the directory in which you are creating the file, or change the directory appropriately. If you accept the default, it will go in the directory you were in when you invoked the Visualizer as the default file for that parameter. If the file already exists, this data will be concatenated onto the existing portion of the file. Click OK to write the data to the file.

17.4 Remove the energy curves by clicking "**Hide all curves**" then "Apply properties" in the curves window.

17.5 **Select a new parameter.** In the GLA01 curves list, select the "Threshold Peak Width (ns)" curve then press "Apply properties" to display. This is the width between the two threshold crossings calculated by our post-processing algorithm. Change the color by selecting "Properties" next to the parameter, selecting a new color, then pressing "Apply properties" again. Exit the curves window by pressing "**Dismiss window**".

17.6 **Zoom** – use the turquoise zoom bars to select a portion of the x direction. If you cannot find the zoom bars, left-click anywhere within the graph and the closest zoom bar should appear, usually they are hiding on the extremes of the x-axis. Click and drag each zoom bar to where you want it. The zoom range is shown in seconds in the text buttons above the curve. Click the "Zoom" button (upper right) to zoom.

17.7 **Changing plot properties to customize plots.** Click the "Plot Props…" button directly under the "Curves…" button. A new window appears that allows you to change plot and axes titles, x-range, y-range, the format of the tick mark labels, and the type of plot (log or linear). Change the y-range to go from 0 to 1000. Push the "OK" button in bottom of window. You now should just see the portion of the curve that lies between 0 and 1000 ns.

17.8 **Show region on ground track.** Push the "Show on Ground Track" button for this zoomed window. Bring the "Groundtracks window" into the foreground by clicking on it and see that this portion is highlighted on the groundtrack. The actual ground track from the full rate data is being plotted now. Select "Greenland" and press "Replot Map" to see a close-up of the region. If you right-click on the zoomed plot to see the red line then press "Show on Ground Track", the teal cube changes position.

17.9 **Get rid of windows.** Bring the zoomed "WF Char" window to the foreground by clicking on it and push the "Done" button in the top right hand corned. Bring the original "WF Char" window to the foreground and push the "Done" button on it.

Step 18.0 **"GLAS ELEVATION" plotset.** Bring this window to the foreground by clicking in it. If you inadvertently closed it, just go back to the "GLAS Series Plot Sets" window, select "Elevations" and "Display Selected Plotsets" again.

The curves available in this plot set for GLA01 and GLA05 are:

- Surface Elevation – from the preliminary range on GLA05
- Noise – GLA05
- Transit Time – GLA05
- Background – GLA01
- On-board DEM – GLA01
- Surface Types – this is a code saying whether on-board DEM had this surface coded as land, and/or ice sheet, and/or sea ice, and/or ocean – GLA01

18.1 **Look at the difference** between the on-board DEM max and min. Click the "Choose Curves" button by the difference plot at the bottom of this window. Choose the on-board DEM max as the first curve and the on-board DEM min as the second curve. Press "Apply selection" when done. The difference plot now shows the difference between these two values.

Step 19.0 **Look at Waveforms and Waveform parameterization.** In the "GLAS ELEVATION" window, right-click anywhere on either graph. Then click the "Display Waveforms" button at the top of the screen. A "WAVEFORMS" window pops up showing 20 waveforms. The caption on each waveform lists the following its unique index, UTC and shot number; latitude and longitude; altitude. The raw waveform is in red and the fit is in blue. If you don't see two blue lines for the fit on the plot, scroll through the waveforms using the "next" or "page" buttons until you do. If we had not selected GLA05 you would only see the raw waveform. These are referred to as waveform thumbnails. The "Curves…" button on this multi-waveform plot gives you the same selection as on an individual waveform plot. On each plot set that is open a vertical red line appears showing the location on the plot set of where the waveforms are. We will now zoom an individual waveform and play with the parameters there since it is easier to see.

19.1 **Zoom waveform:** Left click on a waveform thumbnail and a "Zoomed Waveform" window appears. The curves button allows you to look at all the parameters on the product that we could plot on the waveform.

19.1.1 **Check the standard fit:** Using the "Curves…" button, on the GLA01 tab, unselect the "Obs Mean Background, Volts", "Observed Background Std Dev, Volts" and "Tx Pulse, Volts". Press the "Apply properties" button. Now you have left the return pulse in red and the standard fit in blue. The vertical blue lines show signal-begin and signal-end using the standard parameters.

19.1.2 **Turn off the standard fit curves:** Click the "Curves.." button. On the "GLA05 Std Fit" tab, unselect the "Model, (Standard Fit), Volts" curve and the "Signal Range" (Std Fit) curve. Press the "Apply properties" button. All you see is the red return pulse curve now.

19.1.3 **Check the alternate fit**: Click the "Curves…" button. On the "GLA05 Alt Fit" tab, select the "Model, (Alternate Fit), Volts" curve and the

"Signal Range" (Alt Fit) curve. Press the "Apply properties" button. This shows you the alternate fit in a bright green color. Change the color by clicking on the "Properties" buttons by the two curves and changing the color. Press the "Apply properties" button when done. Exit the curves window by pressing the "Dismiss window" button.

19.1.4 **Look at individual waveform flags**: Click the "Show Flags" button. A window with an interpretation of the waveform quality flags pops up. This shows you which regional mask (the detailed mask, not the on-board mask) the data is in and any problems with the waveform. You must click the "OK" button in this window to remove it before you can continue.

19.1.5 **Change plot properties to zoom waveform:** Click the "Plot Properties…" button then "Modify Plot Properties…". Change the y-range from 0.0 to 1.4 and the x-range from 200.0 to 600.0. Push "OK". Note the waveform plot is immediately replotted with these properties.

19.1.6 Close "**ZOOMED WAVEFORM**" window. Push "DONE" button in the top right hand corner.

19.1.7 **Page through the waveforms.** Bring the "WAVEFORMS" window to the foreground by clicking in it. Be careful: if you click on a waveform plot you will bring up a zoomed waveform. Just close it if you do. You can scroll backwards and forwards by either one waveform, by pushing "< previous" or "next>"; or by a complete page of 20, by pushing "<<page" or "page>>". The red vertical line on the elevation plot set window moves with you.

Step 20.0 **Pick another track within original selection.** Close the "WAVEFORMS" window by pushing the "DONE" button in that window. Close the "GLAS ELEVATION" plotset by pushing the "Done" button in that window. Close the "GLAS Series Plot Sets" window by pushing the "Done" button in that window. Bring the "Elevation PROFILES" window to the foreground. Click on a different Elevation profile. That track will be highlighted in the "groundtracks" window and the "GLAS Series Plot Sets" window reappears with the new pass number.

Step 21.0 End program. Close any windows you have open that have a "done" button by clicking it. You should be left with the "Groundtracks" and "Elevation Profiles" windows open. Click the "Back to Data Selection" button in the "Elevation Profiles" window to close all windows except for the data selection window. If you are exiting the Visualizer, press the "Exit" button.

5.2 Waveform and Elevation Scenario 2

The purpose of this scenario is to select a small region and look at interconnectivity between products. These instructions are very condensed and assume you have already completed scenario 1.

To invoke the visualizer refer to section 4.0.

Step 1.0 Same as scenario 1

Step 2.0 Same as scenario 1

Step 3.0 Same as scenario 1

Step 4.0 Choose products, select GLA01, GLA05, GLA06, GLA12, GLA13, GLA14, GLA15

Step 5.0 Same as scenario 1 (Select all of Greenland).

Step 6.0 Select ground tracks in this region (2, 10).

Step 7.0 Push "continue" on the SCF Viewer window, then "visualizer" on the Browser/Visualizer Viewer window, to start visualizing data.

Step 8.0 Zoom ground track window to Greenland to show data better.

Step 9.0 Select pass 21030020002 from the decimated profile (top left).

Step 10.0 Select "Elevations" and "Range increments" plot sets.

Step 11.0 Bring the **GLAS ELEVATION** window to the foreground. This plot set initially shows "Surface Elevation", "Geoid", and "DEM Elevation".

Step 12.0 **Output the values in a curve to an ASCII file using "Dump Field".** This allows you to dump to an ASCII file the product-file field that was plotted as that curve, along with the unique index, shot number, time (J2000 UTC seconds), latitude, and longitude, for each shot or record. So far this is only available for GLA06, 12, 13, 14, and 15 curves on the Elevations, Corrections, Meteorology, Range Increments, and Flags series plotsets. To create a file for the surface elevation, press "Curves…". On the GLA06 tab, find "d_elev". Press the "Output" button then "Dump Field". A new window pops up that lets you choose the file in which to write the data. Make sure you have write permissions in the directory in which you are creating the file or change the directory appropriately using the "Choose" button. The default is the directory that you were in when you invoked the visualizer. Type in the output file name. You may also select to have an existing file appended to and may add comments that will be included in the header of the dump output file. Click "GO" to write the data to the file.

Step 13.0 Bring the **GLAS RNGINCR** (range increments) window to the foreground. Remove all the default curves by pressing "Curves…", "Hide all curves", then "Apply properties". Proceed to select from the GLA06 tab, "Icesheet Range Increment" and "Land Range Increment". Then press "Apply properties" to display.

Step 14.0 Look at **differences** in the range increments due to the algorithms used to produce the product. If you difference the GLA06 "Icesheet Range Increment" from the "Land Range Increment", you will see that they are quite different, since the land algorithm uses the centroid of the waveform from signal begin to signal end and the ice sheet algorithm uses the centroid of the Gaussian of the last peak.

Step 15.0 Right click on a region on the graph created in step 10 where the differences are noticeable, then click the "**Display Waveforms**" button in the upper left. The waveforms will pop up and by selecting different parameters to plot on the waveforms and zooming where appropriate, you can see why the two answers are different and how the algorithms were implemented.

Continue going through the plotsets differencing values from different products so you can see how they interconnect.

5.3 Viewing GLA04-LPA Data

To invoke the visualizer refer to section 4.0.

Step 1.0 Follow steps 1 to 12 as in scenario 1. To view GLA04 LPA products, it is necessary to have another product with latitude and longitude on it along with GLA04, since GLA04 does not have these parameters. Therefore, GLA01 will be automatically selected in addition to GLA04. Note that currently only GLA04-LPA can be visualized.

Step 2.0 **Zoom in the "Groundtracks" window to enlarge region of interest.** Under "Select Region" push the radio button next to Greenland. Then push "Replot Map" (top left just above map). A blow up of the Greenland region appears.

Step 3.0 **Look at product parameters for a specific pass.** Right clicking with the mouse in any profile box will show that pass highlighted in the "Groundtracks" window. Go to the "Elevation PROFILES" window and left click in the top profile. A "GLAS Series Plot Sets: Pass 21030020002" window will pop up and the ground track for this pass is highlighted in the "Groundtracks" window.

Step 4.0 Click on **Laser Profiling Array** (**GLA04LPA**) button from the "GLAS Series Plot Sets: Pass 21030020002" window and then click on the "Display Selected Plotsets" button. A "GLAS LPA: Pass 21030020002" window will appear, which displays 20 thumbnail images of the Laser Profiling Array. The caption on each thumbnail image lists the unique index, shot number, and UTC.

The user can change plot properties of the thumbnail images, scroll the images by page, zoom an image, or print a postscript file of the images.

5.4 Lidar Scenario

The purpose of this scenario is to look at the atmosphere data to see what the calibrated backscatter profiles and images look like. This exercise looks at GLA07 and GLA09.

To invoke the visualizer refer to section 4.0.

Step 1.0 - Step 3.0: **Invoke visualization GUI**: are the same as for waveform and elevation scenario 1 above.

Step 4.0 **Choose products**. Go to the top left and push the button "Data Product Menu". The Product Selection window pops up. Click the squares next to the atmosphere products, GLA07 and GLA09. Push "Done" in bottom of product selection window. You should now be returned to the SCF Viewer window.

Step 5.0 - Step 10: **Select geographic region and tracks**: are the same as for waveform and elevation scenario 1 above.

Step 11.0 - Step 12: **Start visualizing data**: are the same as for the waveform and elevation scenario 1 above.

Step 13.0 First a "**Cloud Images**" window will pop up showing decimated lidar images of each pass selected. Since GLA07 data are available, these are attenuated backscatter images. Next a "Groundtracks" GUI will pop up showing the groundtracks on a map. These are also decimated.

Step 14.0 - Step 15: Zoom the groundtracks window to enlarge a region of interest and choose a specific pass from the Cloud Images window. These are the same as for waveform and elevation scenario 1 above.

Step 16.0 Select what set of parameters to view. In the "**GLAS Series Plot Sets**: Pass "21030020002" window the parameters have been grouped by subject matter into plot sets. The plot sets available to look at are dependent on what products you selected. Since GLA07 and GLA09 products were selected, you should see the following plot sets highlighted:

- Elevations
- Angles
- Meteo, Cloud, Aero Parameters
- Normalized Lidar Image, 532nm
- Normalized Lidar Image, 1064nm
- Attenuated Backscatter Image, 532nm
- Attenuated Backscatter Image, 1064nm
- Energies and Backgrounds
- Flags

Click the boxes next to “Attenuated Backscatter Image, 532 nm” and “Attenuated Backscatter Image, 1064 nm”. Then push the “Display Selected Plotsets” button. It will take a minute or so to load the parameters. Two windows will appear: one with “GLAS 532nm Attenuated Backscatter” and one with “GLAS 1064nm Attenuated Backscatter”. It’s interesting to notice the difference between the 1064 nm and 532 nm channels. Close the “GLAS 1064nm Attenuated Backscatter” window by pressing the “Done” button when done.

Step 15.0 Bring the “**GLAS 532 nm ATTENUATED BACKSCATTER**” window to the foreground. This is the GLA07 attenuated backscatter profile image overlaid with GLA09 cloud layer data. By default, only the part from -1km to 20km altitude is shown; if there is any cloud data above 20km, the full range to 41km is shown. You may change this by using the “Properties” button to modify the plot’s Y range.

16.1 Zoom – use the turquoise zoom bars to zoom a portion of the x direction. Click and drag each zoom bar to where you want it. The zoom range is shown in seconds in the text buttons above the curve. Click the “Zoom” button (upper right) to zoom. Press the "Done" button when finished looking at the zoomed image.

16.2 Right clicking on the image, then clicking the “Display Lidar Profiles” button will bring up individual thumbnail profiles. There is one thumbnail profile for every laser shot. The caption on each profile lists the unique index (NOT UTC!), shot number, latitude, longitude, and solar angle.

16.3 Page through the thumbnail profiles. You can scroll backwards and forwards either by a single laser shot, by pushing “< previous” or “next>”; or by an entire page of 20, by pushing “<<page” or “page>>”. The red vertical line on the lidar energy plot set moves with you.

16.4 Click on one of the profiles to zoom it. The curves plotted include:

- 532 attenuated backscatter at 40 Hz
- 532 attenuated backscatter at 5 Hz
- 1064 attenuated backscatter at 40 Hz
- 1064 attenuated backscatter at 5 Hz
- 532 nm molecular backscatter X-Section
- 1064 nm molecular backscatter X-Section

16.5 Close “ZOOMED LIDAR” window. Push the “DONE” button in the top right hand corner. Bring the "LIDAR" window to the foreground and push the “DONE” button in the top right hand corner to close it.

Step 17.0 If the “**GLAS 532nm ATTENUATED BACKSCATTER**” window is not in the foreground, bring it there again. On the image are plotted the cloud and aerosol layer heights (tops and bottoms separately), and the ground detection. They are available at different resolutions.

17.1 Zoom – use the turquoise zoom bars to zoom in on a portion of the image. Choose an area that shows several cloud layers. Then push the "Zoom" button to zoom.

17.2 Bring the zoomed window to the foreground. The many curves make the plot somewhat difficult to follow, so click "Curves…", "Hide all curves", "Apply properties" to turn them off.

17.3 With the curves window still up, select from the GLA09 curve list,"DEM Height (m)" by indenting the button under "Show", and then click "Apply properties".

17.4 Now turn on some cloud layers. Select from the GLA09 curve list "Cloud Top (m) Level 1 Low Res" then click "Apply properties" to display. Notice that several horizontal bars appear… these are the top of the first cloud layer.

17.5 Select from the GLA09 curve list "Cloud Bottom (m) Level 1 Low Res" then click "Apply properties" to display. The bottom of the first cloud layer is now shown in magenta. (Cloud layers are counted from the top down.)

17.6 Repeat steps 5.5 and 5.6 for Level 2 and then for Level 3. Each time, notice the new bars that appear.

17.7 For the "Differences" plot at the bottom of the window, click the "Choose Curves" button. Under the GLA09 curve list, choose "Cloud Top (m) Level 1 Low Res" as the first curve and "Topographic Elevation (m)" as the second curve. Press "Apply selection" when done. The difference plot now shows the height of the first cloud top above the topography.

Step 18.0 Now bring each of the "**GLAS 532nm ATTENUATED BACKSCATTER**" windows to the foreground and close by pushing the "DONE" button. Finally, bring the "GLAS Series Plot sets" window to the foreground and push the "DONE" button to close it.

Step 19.0 Pick another track within original selection. Bring the "**Cloud Images**" window to the foreground. Click on a different lidar image. That track will be highlighted in the "groundtracks" window and the "GLAS Series Plot Sets" window reappears with the new pass number.

Step 20.0 **End program**. Close any windows you have open that have a "done" button by clicking it. You should be left with the "Groundtracks" and "Cloud Images" windows open. Click the "**EXIT PROGRAM**" button in the "Cloud Images" window. In your original terminal window you should now have a UNIX prompt.

5.5 Browsing Data Products

Steps:

1. To invoke the visualizer refer to section 4.0.

2. Follow steps 1 to 12 as in scenario 1, except that GLA06 data products should be chosen.

3. Select "View Browse Products" from the "Browse/Visualizer Viewer" window. Select a png file to display, i.e**. GLA06_03102119_r9268_531_L2A.P0469_01_00_0001.png**. For a description of browse products, click on "Browse Product Description" from the "Browse/Visualizer Viewer" window.

For the data product chosen in this example (GLA06) the Browse Product window display the following:

Global Summary Data:

- Product name, granule name, and data start and end times.

- Data averaged over consecutive 100-km segments of the ground track are presented on a map and in a plot as a function of along-track distance, for standard parameterization.

The following parameters versus along-track distance are plotted:

- Elevation wrt Ellipsoid
- Surface Roughness
- Max Amplitude of raw waveform
- Reflectivity
- Surface Slope

On the scatter plots, gray vertical lines extend to +/- 1 standard deviation. Where these lines are missing, they are small compared to the symbol. The starting and ending latitude and longitude are given at the left and right ends of each panel, below the x-axis. Asterisks on the lower and upper axes show out-of-bounds data.

The "Data Nonavailability" plot in the lower right corner is a summary bar plot showing data problems for the granule. It gives the percent of waveforms that contain saturated data, for which the analysis was not able to obtain an acceptable fit to the multi-Gaussian function.

NO GOOD DATA means all relevant data for this time period are missing or bad.

NOT AVAILABLE or N/A may appear on browse products generated after production processing, when only the product file is available. This indicates that the information to compute the parameter is not on the product file.

Summary 1:

Ground track maps and plots as a function of along-track distance accompanied by histograms are displayed. The parameters plotted here are the following:

- Sigma of the fit (not available for GLA06)
- Skewness and Kurtosis for single peak waveforms
- Difference of Centroid of raw waveform and Center of peak of fit.
- Number of peaks in final fit.

Summary 2:

Ground track maps and plots as a function of along-track distance accompanied by histograms are displayed. The parameters plotted here are the following:

- Wet and dry troposphere adjustments
- Ocean tide adjustment
- Solid earth tide adjustment
- Load tide adjustment.

Summary 3:

Standard deviation, maximum and minimum values, average and number of measurements for wet and dry troposphere adjustments, ocean tide adjustment, solid earth tide adjustment and load tide adjustment are displayed.

5.6 Using the Specific Data Set Option

Using the "Select from Specific Data Set" option of the visualizer will allow you to view any single product file or set of time-correlated product files.

To invoke the visualizer refer to section 4.0.

Step 1.0 Push "**Select from Specific Data Set**". The GLAS Manual Data Set Selector GUI appears.

Step 2.0 Change "**Data Release**" to 31.

Step 3.0 Set the **Default Directory** to **/SCF/product_sets/R31_tutorial_data**. You may type in the default directory or click the "pick" button located after the default directory.

Step 4.0 **Choose products**. You may select one file for each product. It is best if these product sets overlap in time, therefore, pick files that correspond in name.

Step 5.0 Click "**Display Data**". The Groundtracks window and Elevation Profiles and/or Cloud Images windows will appear.

5.7 Creating Subsetted Products

To invoke the visualizer refer to section 4.0.

Step 1 Follow steps 1 to 4 as in scenario 1.

Step 2 **Select geographic region.** Push "Show GLAS Coverage on Map" button half way down the GUI on the right. The Map GUI should now pop up. At the top under "Select Region:" push the button next to Greenland. Push the "**Plot Map**" button to replot the map only for the Greenland Region. Next, to zoom a portion of Greenland, press down the left mouse button and drag the cursor to define a box, dragging from its upper left corner to its lower right corner. When the button is released, the region will automatically zoom.

Step 3 Follow steps 8 to 11 as in scenario 1 to select tracks and start accessing the data.

Step 4 Click "**Create Subset Products**" in the intermediate window that pops up.

Step 5 A window will pop up allowing you to select a path and name for the output data. **Make sure that you have write permission to the output directory you select**. Select the directory in the box and either double-click the left mouse button or push "**filter**" to see the subdirectory in the selection box. Now, if you type in a suffix after the subdirectory, the subsetted files will take on that suffix in their names.

For example, specifying /SCF/product_sets/test/Kris will create the following files:

/SCF/product_sets/test/BNA01_Kris.00000001
/SCF/product_sets/test/GRA01_Kris.00000001
/SCF/product_sets/test/GLA01_Kris.00000001
/SCF/product_sets/test/PS01_Kris.00000001
/SCF/product_sets/test/UR01_Kris.00000001
/SCF/product_sets/test/BNA03_Kris.00000001
/SCF/product_sets/test/GRA03_Kris.00000001
/SCF/product_sets/test/BNA04_Kris.00000001
/SCF/product_sets/test/GRA04_Kris.00000001
/SCF/product_sets/test/BNA05_Kris.00000001
/SCF/product_sets/test/GRA05_Kris.00000001
/SCF/product_sets/test/GLA05_Kris.00000001
/SCF/product_sets/test/PS05_Kris.00000001
/SCF/product_sets/test/UR05_Kris.00000001

Note: If subsetting GLA03 or GLA04, you must also subset GLA01 to create their BN and GR files. Subsetting GLA01 automatically creates BN and GR files for GLA03 and GLA04 files regardless of whether they are selected. If they were not selected, just remove these files.